PTO/SB/05 (11-00)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

11-16-00 A

Please type a plus sign (+) inside this box → +

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	GTRC77
First Inventor	JAYARAMAN, Sundaresan
Title	A NOVEL FABRIC-BASED SENSOR FOR MONITORING VITAL SIGNS
Express Mail Label No.	EL682512478US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [X] Fee Transmittal Form (e.g., PTO/SB/17) *(Submit an original and a duplicate for fee processing)*
2. [X] Applicant claims small entity status. See 37 CFR 1.27.
3. [X] Specification [Total Pages 19 / 13]
   (preferred arrangement set forth below)
   - Descriptive title of the invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. [X] Drawing(s) *(35 U.S.C. 113)* [Total Sheets 3]
5. Oath or Declaration [Total Pages 2]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 CFR 1.63 (d)) *(for continuation/divisional with Box 18 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. [ ] Application Data Sheet. See 37 CFR 1.76

ADDRESS TO:

Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

7. [ ] CD-ROM or CD-R in duplicate, large table or Computer Program *(Appendix)*
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] paper
   c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. [X] Assignment Papers (cover sheet & document(s))
10. [ ] 37 CFR 3.73(b) Statement [ ] Power of Attorney *(when there is an assignee)*
11. [ ] English Translation Document *(if applicable)*
12. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
13. [ ] Preliminary Amendment
14. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Request and Certification under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. [ ] Other: .....

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:*

[ ] Continuation [ ] Divisional [X] Continuation-in-part (CIP) of prior application No: 09/157,609 filed Sept. 21, 1998 09/273,195 filed March 19, 1999

Prior application information: Examiner _____ Group Art Unit: .....

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying con ... and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inac ... ted application parts.

19. CORRESPO

[X] Customer Number or Bar Code Label (Insert Customer No. or Attac) 006980 PATENT AND TRADEMARK OFFICE [ ] Correspondence address below

Name	Todd Deveau TROUTMAN SANDERS LLP				
Address	Bank of America Plaza, Suite 5200 600 Peachtree Street, N.E.				
City	Atlanta	State	Georgia	Zip Code	30308-2216
Country	USA	Telephone	404.885.2761	Fax	404.962.6845

Name (Print/Type)	Todd Deveau	Registration No. (Attorney/Agent)	29,526
Signature	Todd Deveau	Date	16 Nov. 2000

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231.

PTO/SB/17 (09-00)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

U.S. PTO
09/713161
11/14/00
JC921

FEE TRANSMITTAL for FY 2001

Patent fees are subject to annual revision.

TOTAL AMOUNT OF PAYMENT ($) 355.00

Complete if Known

Application Number	
Filing Date	
First Named Inventor	JAYARAMAN, Sundaresan
Examiner Name	
Group Art Unit	
Attorney Docket No.	GTRC77

METHOD OF PAYMENT

1. ☐ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit Account Number: 20-1507

Deposit Account Name: TROUTMAN SANDERS LLP

☒ Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17

☒ Applicant claims small entity status. See 37 CFR 1.27

2. ☒ **Payment Enclosed:**

☒ Check ☐ Credit card ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	710	201	355	Utility filing fee	355
106	320	206	160	Design filing fee	
107	490	207	245	Plant filing fee	
108	710	208	355	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) ($) 355.00

2. EXTRA CLAIM FEES

	Extra Claims		Fee from below	Fee Paid
Total Claims	12 -20** =	0	X	=
Independent Claims	1 -3** =	0	X	=
Multiple Dependent				=

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	80	202	40	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim, if not paid
109	80	209	40	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for *ex parte* reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	390	216	195	Extension for reply within second month	
117	890	217	445	Extension for reply within third month	
118	1,390	218	695	Extension for reply within fourth month	
128	1,890	228	945	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,240	241	620	Petition to revive - unintentional	
142	1,240	242	620	Utility issue fee (or reissue)	
143	440	243	220	Design issue fee	
144	600	244	300	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	710	246	355	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	710	249	355	For each additional invention to be examined (37 CFR § 1.129(b))	
179	710	279	355	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($)

SUBMITTED BY				Complete (if applicable)	
Name (Print/Type)	Todd Deveau	Registration No. (Attorney/Agent)	29,526	Telephone	404.885.2761
Signature				Date	19 Nov. 2000

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

Patent
Customer No.: 006980
Express Mail No.: EL682512478US
Express Mail Date: 14 November 2000
Docket No.: GTRC77
Document No.: 645595

APPLICATION FOR LETTERS PATENT
UNITED STATES OF AMERICA

Be it known that we, Sundaresan Jayaraman, a citizen of the United States, residing at 2125 Castleway Drive, N.E., Atlanta, Georgia 30345, and Sungmee Park, a citizen of Republic of Korea, residing at 3825 Lavista Road, Apt. No. #Z-3, Tucker, Georgia 30084, have invented certain new and useful improvements in a

A NOVEL FABRIC-BASED SENSOR FOR MONITORING VITAL SIGNS

of which the following is a specification.

TROUTMAN SANDERS LLP
Bank of America Plaza, Suite 5200
600 Peachtree Street, N.E.
Atlanta, Georgia 30308-2216 USA
404.885.2761

A NOVEL FABRIC-BASED SENSOR FOR MONITORING VITAL SIGNS

This application is a continuation-in-part of U.S.S.N. 09/157,607, filed on September 21, 1998, now U.S. Patent No. 6,145,551, and is a continuation-in-part of U.S.S.N. 09/273,175, filed on March 19, 1999.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a fabric-based sensor for monitoring vital signs or other electrical impulses of a subject. The sensor is woven or knitted from conductive fibers and, when in contact with the body, is capable of receiving signals from the wearer and transmitting them to a processing or monitoring device through a data-output connection or terminal. The sensor may be integrated into a garment or used as independently as a conductive patch, and it may provide bi-directional communication by sending electrical impulses back to the subject.

2. Background of the Art

Conventional medical electrodes are used for sensing electrical transmission between the surface of a subject's skin and electrical leads connected to monitoring equipment. Typically, the electrodes use an adhesive backing to affix the conductive lead to the subject's skin. A conductive gel is often used to enhance electrical transmission.

Many of the existing sensors are either rubberized electrodes or gel-based sensors that stick to the body of the subject. Both types of sensors have the major drawbacks of being difficult to remove and causing skin irritation and chafing.

U.S. Patent Nos. 4,722,354 and 5,450,845 to Axelgaard describe an electrical stimulation electrode which integrates conductive fibers with pre-wired, hard-wired electrical leads into a flexible electrode patch. The flexible patch allows for greater patient comfort and movement, without disruption of the electrode placement. The patch described by Axelgaard consists of several layers, including a non-conductive layer, an adhesive layer and the conductive fiber layer.

Co-pending application U.S.S.N. 09/157,607, filed on September 21, 1998, now U.S. Patent No. 6,145,551 to Jayaraman, et al., incorporated herein by reference in its entirety as if fully set forth herein, discloses a process for the production of a woven garment which can accommodate armholes and which may also incorporate conductive fibers integrated into the woven fabric by one weaving process. The garment produced by the Jayaraman process is capable of collecting data from several different types of sensors attached thereto, and transmitting the data through a single connector, such as a snap T-connector.

Additionally, co-pending application U.S.S.N. 09/273,175, filed on March 19, 1999 by Jayaraman et al., and incorporated by reference in its entirety as if fully set forth herein, discloses a fabric or garment which includes an integrated information infrastructure for collecting, processing, transmitting and receiving information. The garment functions as a "wearable motherboard," which, by utilizing the interconnection of electrical conductive fibers, integrates many data-collecting sensors into the garment without the need for multiple stand alone wires or cables. The information may be transmitted to several monitoring devices through a single electronic lead or transceiver.

There exists a need in the art for a flexible electrode which can adhere to the subject without the need for pain-causing adhesive. The present invention is directed to a conductive fabric sensor which does not include multiple layers such as the Axelgaard electrode and, when in contact with the body, picks up electrical signals from the wearer. Utilizing the weaving technique and the interconnection of electrical conductive fibers of the co-pending Jayaraman application and the Jayaraman patent, it is possible to produce a comfortable fabric-based sensor which is very light weight and does not require hard wiring or adhesives.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a fabric-based sensor for monitoring vital signs and other electrical impulses of a subject, which sensor does not require the use of adhesives.

It is a further object of the invention to provide a garment having at least one fabric-based sensor for monitoring vital signs and other electrical impulses of a subject, wherein the sensor is knitted or woven within the garment and does not need to be attached as a separate component to the garment by hard-wiring or by a connector such as a snap connector.

It is still another object of the present invention to provide a fabric-based sensor capable of bi-directional communication.

One innovative facet of the present invention is the ability to monitor vital signs and other electrical impulses using a fabric patch woven or knitted from conductive fibers, which patch eliminates the need for adhesives to position an electrode on the subject. The conductive fabric may be used alone or it may be integrated into a garment containing other fibers. Additionally, the conductive patch may be used to send and receive electrical impulses to and from a remote source.

In a first embodiment, a fabric-based sensor for monitoring vital signs and other electrical impulses of a subject is provided. The sensor is made from knitted or woven non-insulated, conductive fibers attached to a data-output terminal, for example a snap connector. The fabric is directly contacted with a subject's skin, eliminating the need for a backing material or conductive gel, although conductive paste may optionally be used. The sensor directly contacts the skin, receiving the electrical signals and transmitting them to the data-output terminal, which relays the signals to a monitoring device. Optionally, the fabric-based sensor may include a conductive paste between the sensor and the data-output terminal. The sensor may be plugged into the connectors of the "wearable motherboard" described in U.S.S.N. 09/273,175 or to other monitoring devices.

In a further embodiment, a garment having at least one fabric-based sensor for monitoring vital signs and other electrical impulses of a subject, wherein the sensor is knitted or woven integrally within the garment is provided. By knitting or weaving a conductive fiber integrally into a fabric, a garment may be created entirely out of the conductive fibers or may have one or more distinct patches of the conductive fabric. A conductive patch or conductive patches, comprised of the woven or knitted conductive fibers and a data-output terminal, optionally with conductive paste, may be incorporated into the garment at positions necessary to obtain a desired signal. For example, several conductive patches may be knitted or woven or sewn into a shirt at positions appropriate for obtaining pulse or temperature. These readings are obtained from the fibers, transmitted to the connectors and then transmitted to a monitor or other processor for interpretation.

In another embodiment, a conductive fabric patch for providing bi-directional communication to and from a subject is provided. The fabric-based sensor of the present invention, used either independently or incorporated integrally into a garment, may be used to transmit vital signs and other electrical impulses from the subject to a monitoring source. Additionally, the conductive patch may receive electrical signals from an external source. The patch may be used to provide an electrical charge to a subject, for example, an electric shock to a baby with apnea.

It can be seen from the description herein of our invention that a fabric-based sensor made of conductive fibers is provided, which can be incorporated into a full-fashioned woven or knitted garment, which can be used for monitoring vital signs or sending electrical pulses to the subject. These and other objects and advantages of the present invention will become apparent upon reading the following specification and claims in conjunction with the accompanying drawing figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates the design of the fabric-based sensor of the present invention, showing both a woven conductive patch and a knitted conductive patch.

Fig. 2 illustrates a front view of a garment having a fabric-based sensor integrated therein.

Fig. 3 illustrates an opened view and details of a garment having a fabric-based sensor integrated therein.

DETAILED DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENT

A. The Fabric-Based Sensor

As illustrated in Fig. 1, a fabric-based sensor for monitoring vital signs and other electrical impulses of a subject is provided. The sensor is made from knitted or woven non-insulated, conductive fabric attached to a data-output terminal, for example a snap connector. The sensor may optionally contain conductive gel. The fabric is directly contacted with a subject's body, eliminating the need for a backing material or adhesive. The sensor directly contacts the skin, receiving the electrical signals and transmitting them to the data-output

terminal, which relays the signals to a monitoring device or other information processing device.

Conductive fabric sensors can be incorporated into fabric by any conventional method, for example by knittng or weaving. Sensors can be made from other types of conducting fibers, depending on fabric densities and structures.

1. Knitted Fabric Sensor

Any yarn applicable to conventional knitted fabrics may be incorporated with conductive fibers into the conductive fabric sensor of the present invention. The choice of material for the non-conductive yarn will ordinarily be determined by the end use of the fabric and will be based on a review of the comfort, fit, fabric hand, air permeability, moisture absorption and structural characteristics of the yarn. Suitable yarns include, but are not limited to, cotton, polyester/cotton blends, microdenier polyester/cotton blends and polypropylene fibers such as MERAKLON (made by Dawtex Industries).

The table provided below shows the parameters used for producing the knitted fabric sensor embodiment of the present invention. The information provided is exemplary only, and is not intended to limit the scope of the present invention.

Knitted Fabric Sensor

Material	Uninsulated 100% Stainless Steel Yarn
Part #	VN 12/1 X 275/100Z/316L
Source	Bekaert Corporation
Yarn Size	2250 Denier
Fabric Structure	1 x 1 Rib
Fabric Density	16 Wales/Inch and 18 Courses/Inch
Sensor Size	1.5" x 1.5"
Sensor Weight	12 oz/yd^2

2. Woven Fabric Sensor

The table provided below shows the parameters used for producing the woven fabric sensor embodiment of the present invention. The information provided is exemplary only, and is not intended to limit the scope of the present invention.

Woven Fabric Sensor

Material for Warp	Cotton
Yarn Size (Warp)	18s Ne
Material for Filling (Weft)	Uninsulated 100% Stainless Steel Yarn
Yarn Size (Weft)	2250 Denier
Filling Yarn Part #	VN 12/1 X 275/100Z/316L
Filling Yarn Source	Bekaert Corporation
Fabric Structure	1 x 1 Plain
Fabric Density	30 Ends/Inch and 22 Picks/Inch
Sensor Size	1.5" x 1.5"
Sensor Weight	7.5 oz/yd^2

Additionally, electrical conductive fiber can be used in place of the cotton fiber material for the warp fiber of the above embodiment.

3. Conductive Fibers

Electrical conducting fibers for the fabric sensor include, but are not limited to: (i) doped inorganic fibers; (ii) stainless steel fibers; and (iii) thin gauge copper wires. All of these fibers can readily be incorporated into the fabric sensor. An example of an available conducting fiber is uninsulated X-Static from Squat Industries, Scranton, Pennsylvania. An example of an available thin copper wire is 24 gauge insulated copper wire from Ack Electronics, Atlanta, Georgia.

One example of a highly conductive yarn suitable for incorporation into the fabric sensor of the present invention is Bekinox available from Bekaert Corporation, Marietta, Georgia, a subsidiary of Bekintex NV, Wetteren, Belgium, which is made up of stainless steel fibers and has a resistivity of 60 ohm-meter. The bending rigidity of this yam is comparable to that of the polyamide high-resistance yams and can be easily incorporated. The electrical conductive fiber used in the woven or knitted sensor should preferably be uninsulated.

4. Other Fabrics Useful in the Sensor of the Present Invention

Fabrics having form-fitting properties and high comfort properties may also be used in the fabric sensor of the present invention. The form-fitting component keeps the sensor in place on the subject's body during movement, eliminating the need for adhesive. The material usually has a high degree of stretch to provide the required form-fit.

A preferred form-fitting fabric is SPANDEX fiber, a block polymer with urethane groups. Its elongation at break ranges from 500 to 600 % and, thus, can provide the necessary form-fit. Its elastic recovery is also extremely high (99% recovery from 2-5% stretch) and its strength is in the 0.6-0.9 grams/denier range. It is resistant to chemicals and withstands repeated washings. SPANDEX fibers can be obtained from E.I. du Pont de Nemours, Wilmington, Delaware.

The form-fitting component can take the form of a strap or wrap or other component in conjunction with the woven or knitted fabric sensor into which the form-fitting fiber is integrated in order to hold the sensor in the desired place on the body. Alternatively, where the sensor is integrated within the garment fabric itself, as illustrated in Figs. 2 and 3, or attached to the garment in the form of a sensor patch by, for example, T-connectors, the form-fitting component can be incorporated into the garment itself to hold the sensor patch in the desired location. In this latter case, the form-fitting component can be woven or knitted into the garment fabric, as described in co-pending U.S.S.N. 09/273,175, filed on March 19, 1999.

B. Garment Containing Fabric-Based Sensor

As illustrated in Figs. 2 and 3, the fabric-based sensor 12 described above can be incorporated into a garment, wherein the sensor is itself knitted or woven integrally within the garment fabric 10 to provide monitoring of vital signs or other electrical impulses. By knitting or weaving a conductive fiber into a fabric, a garment may be created entirely out of the conductive fibers or have one or more distinct patches 14 of the conductive fabric. A conductive patch or conductive patches, comprised of the woven or knitted conductive fibers and a data-output terminal 16, optionally with conductive paste, may be incorporated into the garment at positions necessary to obtain a desired signal. For example, several conductive patches may be incorporated into a garment by any known method, including knitting, weaving or sewing. Incorporation into a garment may be at selective positions optimal for obtaining pulse or temperature readings. These readings are obtained from the conductive fibers, transmitted to the connectors and then transmitted to a monitor or other processor for interpretation.

Garments may be fashioned from any conventional knitting, weaving or sewing process. Patches containing the fabric-based sensors of the present invention may be incorporated into the garment by any known technique, including, but not limited to sewing, knitting, weaving, gluing, VELCRO, etc. The patches may be strategically placed to monitor whatever vital sign is contemplated, and several patches may be incorporated into a single garment to monitor different vital signs or electrical impulses.

Garments contemplated by the present invention include, but are not limited to shirts, dresses, pants, undergarments, hats, gloves or other wearable items.

The garments can also be comprised of a form-fitting fiber component, as described above, which serves to secure the conductive fabric and the sensor to the body. The form-fitting fibers also serve to restrict movement of the sensors, thus assuring more consistent monitoring.

C. Sensor Providing Bi-Directional Communication

The fabric-based sensor of the present invention may be used to monitor vital signs or other electrical impulses from a subject. Additionally, the sensor may serve to deliver impulses to the subject from a remote source, thus providing bi-directional communication.

The sensor may be used to monitor respiration, pulse, temperature, EKG, EEG , or other electrical impulses. The fabric-based sensor, therefore, is useful in several medical applications, including but not limited to, continuously or intermittently monitoring (a) patients located nearby or at remote locations, (b) post-operative patients, (c) geriatric patients, mentally ill patients (for a better understanding of diseases such as chronic depression), (d) children susceptible to apnea and SIDS (sudden infant death syndrome), and (e) patients prone to allergic reactions (e.g., anaphylaxis reaction from bee stings).

In conjunction with the monitoring applications described above, the fabric-based sensor of the present invention may be used to send electrical impulses to the patient wearing the sensor. For example, when the sensor detects that a baby susceptible to SIDS has stopped breathing, a small electrical shock can be sent from a monitoring source to the child to stimulate breathing.

While the invention has been disclosed in its preferred forms, it will be apparent to those skilled in the art that many modifications, additions, and deletions can be made therein without departing from the spirit and scope of the invention and its equivalents as set forth in the following claims.

What is claimed is:

1. A fabric-based sensor for transmitting electrical impulses or other vital signs comprising:

(a) a fully-conductive fabric layer of integrated fibers; and

(b) an electrical lead for connection to a data-output terminal, the electrical lead comprising one of the integrated fully-conductive fibers.

2. The fabric-based sensor of claim 1, further comprising a conductive paste between the fiber and the data-output terminal.

3. The fabric-based sensor of claim 1, wherein the fully-conductive layer of fibers are knitted.

4. The fabric-based sensor of claim 2, wherein the fully-conductive layer of fibers are woven.

5. The fabric-based sensor of claim 1, wherein the data-output terminal is a snap connector.

6. The fabric-based sensor of claim 2, wherein the data-output terminal is a snap connector.

7. A garment comprising at least one fabric-based sensor of claim 1.

8. A garment comprising at least one fabric-based sensor of claim 2.

9. A method for monitoring the vital signs or other electrical impulses of a subject comprising applying the fabric-based sensor of claim 1 to the subject and connecting the data-output terminal to a monitor.

10. A method for monitoring the vital signs or other electrical impulses of a subject comprising applying the fabric-based sensor of claim 2 to the subject and connecting the data-output terminal to a monitor.

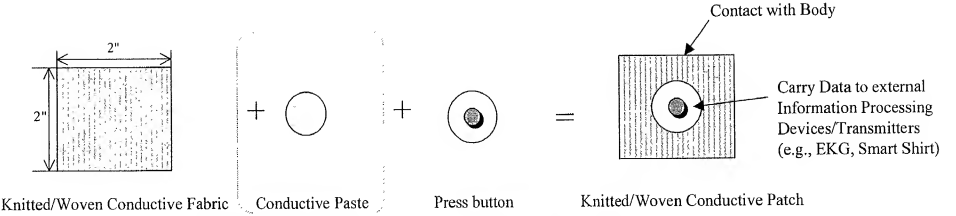
11. A method for providing an electrical impulse to a subject comprising applying the fabric-based sensor of claim 1 to the subject, connecting the data-output terminal to an impulse-delivering device, and delivering the impulse through the sensor.

12. A method for providing an electrical impulse to a subject comprising applying the fabric-based sensor of claim 2 to the subject, connecting the data-output terminal to an impulse-delivering device, and delivering the impulse through the sensor.

A NOVEL FABRIC-BASED SENSOR FOR MONITORING VITAL SIGNS

ABSTRACT

The present invention comprises a fabric-based sensor for monitoring vital signs or other electrical impulses of a subject. The sensor is woven or knitted from conductive fibers and, when in contact with the body, receives signals from the wearer and transmits them to a processing or monitoring device through a data-output terminal. The sensor may be integrated into the fabric of a garment or used independently as a conductive patch. Additionally, the sensor may provide bi-directional communication by both monitoring electrical impulses and sending them.



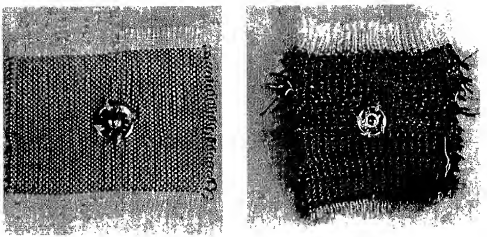


Figure 1. Novel Fabric-based Sensors

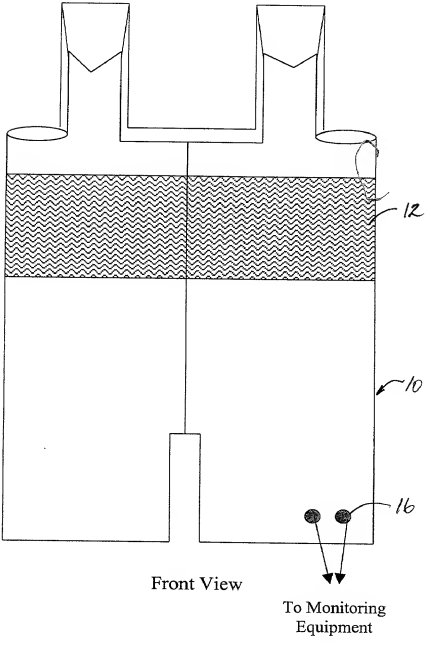


Figure 2

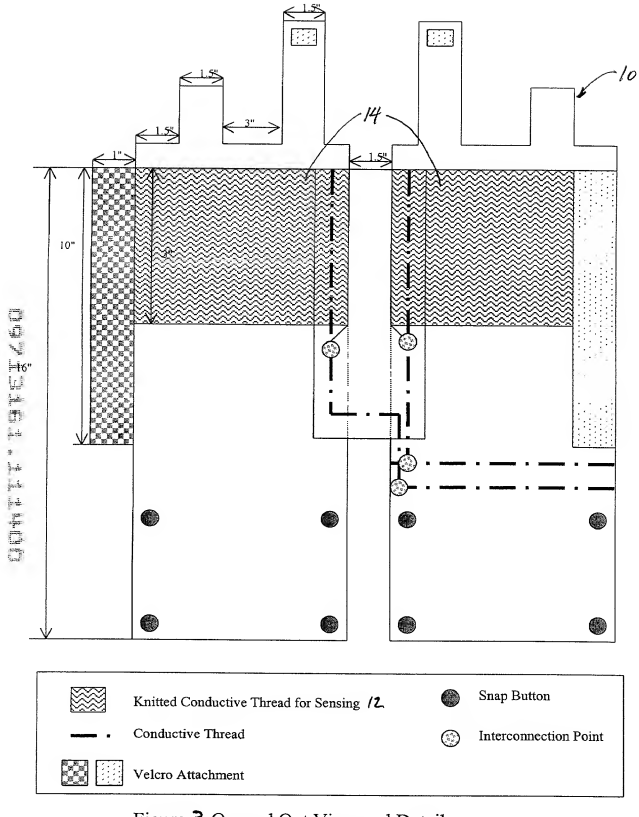


Figure **3** Opened Out View and Details

DECLARATION AND POWER OF ATTORNEY
In Re Application: Sundaresan Jayaraman and Sungmee Park Attorney's Docket No. GTRC77

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name. I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: —**A NOVEL FABRIC-BASED SENSOR FOR MONITORING VITAL SIGNS**, the specification of which:

☒ is attached hereto.
☐ was filed on _____ as Application No. _____ (if applicable) and was amended on _____.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I do not know and do not believe that the same was ever known or used by others in the United States of America before our invention thereof, or patented or described in any printed publication in any country before our invention thereof or more than one year prior to the date of this application. I further state that the invention was not in public use or on sale in the United States of America more than one year prior to the date of this application. *I understand that I have a duty of candor and good faith toward the Patent and Trademark Office* and I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of the foreign application(s) for patent or inventor's certificate listed below, and have also identified below any foreign application for patent or inventor's certificate disclosing subject matter in common with the above-identified specification and having a filing date before that of the application on which priority is claimed:

Application No.	Country	Filing Date	Priority Claimed Under 35 USC §119
			Yes_____No_____

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter disclosed and claimed in the present application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No	Filing Date	Status: patented, pending, abandoned
Serial No. 09/157,607	September 21, 1998	Patented - U.S. Patent No. 6,145,551
Serial No. 09/273,175	March 19, 1999	Pending

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statement were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patents issuing thereon.

POWER OF ATTORNEY: The following attorneys and/or agents are hereby appointed to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: GERALD R. BOSS, REG. NO. 36,460; R. STEVAN COURSEY, REG. NO. 39,949; TODD DEVEAU, REG. NO. 29,526; JOEL S. GOLDMAN, REG. NO. 29,070; W. BROOK LAFFERTY, REG. NO. 39,259; HAROLD L. MARQUIS, REG NO. 20,594; RYAN A. SCHNEIDER, REG. NO. 45,083; GREGORY S. SMITH, REG NO. 40,819; KENNETH SOUTHALL, REG. NO. 38,315; CHARLES L. WARNER, REG. NO. 32,320; and ROGER S. WILLIAMS, REG. NO P43,273

Send correspondence to: **TROUTMAN SANDERS, LLP**
Bank of America Plaza
600 Peachtree Street, N.E., Suite 5200
Atlanta, Georgia 30308-2216

Name of attorney: Todd Deveau
Direct telephone calls at **404.885.2761**:

Full name of first inventor: Sundaresan Jayaraman Citizenship: USA

Inventor's signature Date: Nov 14, 2000

Residence and Post Office Address: 2125 Castleway Drive, N.E., Atlanta, Georgia 30345

Full name of second inventor: Sungmee Park	Citizenship: ~~USA~~ REPUBLIC OF KOREA
Inventor's signature [signature]	Date: 11/14/00
Residence and Post Office Address: 3825 Lavista Road, Apt. No. #Z-3, Tucker, Georgia 30084	